particular BTA, by never entering a combined bid, and by never topping the bid for one of the two blocks when they currently stand as the high bidder for the other block.

At any point in time, either the current high bids on the two separate blocks within a BTA will total to more than the high bid for the combination of both blocks, or the combined bid will top the sum of the individual bids. To simply the following discussion, we refer to the individual bids as being "active" in the first case, and the combined two-block bid as being "active" in the second case.

A bidder will be allowed to top any bid, including its own; in addition, if a bidder's bid is not currently "active", the bidder will be permitted to withdraw that bid. (This is necessary, in order to allow a bidder with limited resources to abandon its quest for a license in one BTA, and begin bidding for a license in another BTA instead. If bids could not be withdrawn, a bidder for a single license could find its currently-inactive bid becoming active again, were the bid for the other single license in the same BTA to be raised sufficiently high.) If a bid is withdrawn, the previous high bid takes its place (and remains, for the time being, inactive); it, too, can of course be withdrawn.

The auction will end when a pre-announced amount of time (e.g., five minutes) passes with no increase in the sum of the active bids.

Note that the amount of information which must be assimilated by a bidder during the bidding is not prohibitively complex. The use of a minimum bid increment will likely be necessary in order to move the auction expeditiously to its conclusion. Such a minimum bid increment could be either a fixed dollar amount, or a percentage increment over the bid being topped.

A bit of a free-rider problem exists in the proposed method: Two applicants, currently the high bidders on the two single licenses within a BTA, facing an active bid for the combination of licenses, could find themselves

each waiting for the other to raise its bid and reactivate both. This problem is mitigated by allowing a bidder to increase its own bid, even when the increase is not sufficient to make the bid active.

Furthermore, a less-than-fully-efficient allocation of blocks across BTAs might result from the use of this procedure. Better would be a procedure which allowed for bidding on all subsets of BTAs and license blocks, but the complexity of the informational feedback from such a procedure is substantial. Hence, the procedure offered here should be viewed as a compromise, likely to lead to a nearly-efficient outcome, while remaining quite practical.

	BTA 1	BTA 2	BTA 3	BTA 4	BTA 5
C	* $xx id#	$xx id#	* $xx id#	* $xx id#	* $xx id#
D	* $xx id#	$xx id#	* $xx id#	* $xx id#	* $xx id#
CD	$xx id#	* $xx id#	$xx id#	$xx id#	$xx id#

	BTA 6	BTA 7	BTA 8	BTA 9	BTA 10
C	* $xx id#	* $xx id#	$xx id#	* $xx id#	$xx id#
D	* $xx id#	* $xx id#	$xx id#	* $xx id#	$xx id#
CD	$xx id#	$xx id#	* $xx id#	$xx id#	* $xx id#

time since last change in active bid : m:ss

In this display, the block-C and block-D licenses in 10 BTAs are being sold. For each BTA, the current high bid and the identity of the current high bidder are displayed for block C, block D, and the combination of blocks C and D. ($xx represents a displayed bid, and id# represents a publicly-known bidder identification number. The asterisks indicate the currently-active bids, i.e., they truly are "asterisks".)

If the total of the bids for blocks C and D separately exceed the bid for the combination of block C and D, asterisks appear next to the two individual bids; otherwise, an asterisk appears next to the combined bid. Bidders are allowed to raise their own bids, if those bids are high and inactive; they are also allowed to withdraw inactive bids (making the previous high bid the new high-and-inactive bid).

A running time-counter at the bottom of the display indicates the length of time that has passed since the last change in active bids, i.e., since the last time the total of the potential winning bids was increased. When the time-counter reaches a prespecified value, the auction is over.

6.   Proposal for the auctioning of block E, F, and G licenses

We propose that the same "two-dimensional" procedure be used here as was proposed for the sale of the C and D blocks. The only change is that more possibilities for aggregation of blocks within a BTA now exist. Two levels of detail are worthy of consideration. At the greater level of detail, all seven subsets (E, F, G, EF, EG, FG, and EFG) can be listed for each BTA. Alternatively, only four subsets can be listed (E, F, G, and EFG); this simplifies the display, but requires that applicants seeking precisely two of the 10 MHz blocks bid for two individual licenses.

All other considerations are the same as those discussed in the previous section.

7.   Auction scheduling

A leisurely schedule would allocate three weeks to the sale of MTA-wide licenses. This would include several days for consideration after the announcement of nationwide bids (if such bids are allowed), and then the sale of block-A and block-B licenses covering four MTAs (i.e., four successive simultaneous-ascending-bid auctions) each day. The sale of block-C and block-B licenses in MTA-sized groupings of BTAs would take at most five weeks (if only two MTAs were covered each day), and the sale of the block-E-through-G licenses would take a similar length of time. In total, the entire allocation process could be completed in no more than three months.

A doubling of this pace might well be possible. This would cut the total time requirement for the allocation of all PCS licenses to a mere six weeks. (However, the slower schedule would allow applicants more time to develop (and modify) their acquisition strategies, and therefore would be likely to yield a somewhat more efficient final allocation of licenses.)

8. Concluding comments

The FCC will soon embark into uncharted waters, as it organizes one of the largest and most complex auctions ever conducted. The voyage will be exciting, and new precedents will be set at each stage of the trip. With a well-chosen approach, the public interest will be served (and, not incidentally, the public treasury will be enhanced).

In this paper, it is reasoned that the offering of nationwide PCS licenses is unnecessary in order to achieve an efficient allocation of licenses, is unlikely to be value-maximizing, and involves dangers in the development of licenses and provision of service to consumers.

The specific proposals of auction procedures presented herein were chosen in order to maximize the efficiency of the final allocation of licenses, and to generate fair market prices for the licenses, while still remaining within the realm of practicability. Other approaches may well be feasible. However, it is strongly recommended that the following issues be kept in the forefront: The procedures finally adopted should be likely to yield an efficient outcome, while at the same time not requiring bidders to engage in overly-complex strategic analysis and not subjecting them to an unassimilatable overload of information at any stage.

9. Author's biography

Robert J. Weber holds the position of Professor of Managerial Economics and Decision Sciences at the J.L. Kellogg Graduate School of Management, Northwestern University. Educated at Princeton (A.B.) and Cornell (M.S., Ph.D.), he was a faculty member of the Cowles Foundation for Research in Economics at Yale prior to joining the Kellogg faculty in 1979. His research generally concerns strategic aspects of economic competition, with primary focuses on auctions and electoral processes. He is the author of more than 40 research papers and has served as a consultant to a variety of private and public institutions.

On the academic side, Professor Weber is co-author of the seminal paper, "A Theory of Auctions and Competitive Bidding" (*Econometrica* 50, 1981), and has published several subsequent articles on the auctioning of multiple items. On the more practical side, in the mid 1980s Professor Weber served as the external consultant on auction theory on the project (sponsored by the Department of the Interior) which developed the methods used to schedule area-wide auctions of petroleum extraction leases on the U.S. outer continental shelf. In June of 1992, he organized (with representatives of the Federal Reserve Board and the Department of the Treasury) and gave the opening address at the public forum which led to the currently-ongoing experiment in the use of uniform-price auctions to place the Treasury's 2-year and 5-year debt issues.

Economically Efficient Licensing Policies for Personal Communication Services

by

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Economically Efficient Licensing Policies for Personal Communication Services

by

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I.   Introduction and Summary

Personal communication services (PCS) represent the
potential for dramatic increases in the quality and variety
of telecommunications services available in the United
States. In its Notice of Proposed Rulemaking (NPRM) of July
16, 1992, the Commission asked for comments on a number of
issues, the resolution of which is likely to strongly
influence the extent to which the potential benefits of PCS
are realized. In these comments I address four of these
issues: (1) the size of the service areas to be licensed
for PCS services; (2) the number of licenses (3, 4, or 5)
to be awarded per service area; (3) the conditions under
which local exchange carriers (LECs) may obtain PCS licenses;

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1983); and consultant to the Rand Corporation (1980-1983). I hold a
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  I have co-authored two books and coedited one book, all on the
economics of communication industries, and have authored or co-authored
numerous articles in professional journals and edited volumes. Much of
this work has focused on economic and policy issues raised by
communication industries. My curriculum vitae is attached at the end of
this paper.

and (4) whether and under what conditions cellular carriers should be allowed to obtain PCS licenses. I also offer a few brief observations on the merits of lotteries versus auctions as mechanisms for awarding licenses and some desirable rules for lottery filings and post lottery conduct.

My conclusions are that the public's interest in PCS will be best served by licensing relatively small service areas, by awarding five PCS licenses for each service area, and by allowing LECs and cellular operators to participate in PCS under the same terms and conditions that will be applied to all other applicants and licensees. These conclusions are supported by both economic theory and an assessment of relevant empirical evidence.

The analysis of service area size is presented in the next section. There I show that small service areas will facilitate the development of a healthy PCS industry that effectively serves the needs of telecommunications users in several ways. (1) Small service areas, by increasing the number of licensees, will permit a greater degree of experimentation under commercial conditions with alternative approaches to PCS than would be possible if fewer (large) service areas were licensed. The industry should be able to conduct commercial experiments with a large number of approaches to PCS early on because of the danger that network industries (like telecommunications industries) will lock-in on inferior approaches adopted before superior alternatives

are trialed; large user bases make it difficult for carriers and users to switch to superior approaches later on. (2) The network nature of telecommunication industries gives rise to an information (contracting costs) problem that makes it harder to split large areas up to create smaller ones than it is to combine small areas to make large ones. This transaction cost asymmetry means that large areas may not be broken up to allow for the implementation of PCS infrastructure and services that best meet the unique needs of individual communities, even when social welfare would be increased by doing so.

Clustering of contiguous service areas under common ownership is less prevalent in cellular than is apparently presumed in the NPRM, and the clusters that are observed do not correspond to either the MTAs or BTAs that have been proposed as service areas for PCS licenses. Furthermore, there are explanations other than the efficiency argument of the NPRM for why regional clusters have historically developed in the cellular industry--including the geometric necessity that geographical clustering must increase as the industry consolidates.

My analysis in Section III shows that five licenses have definite advantages for promoting experimentation with new technologies and for encouraging the development of a diverse array of PCS services.

Section IV considers the advantages and purported disadvantages of allowing LECs to offer PCS anywhere, including in their LEC service areas. The likelihood of significant economies of scope, the roles of LECs in providing universal service and implementing new telecommunications technologies, and the fact that LEC participation is unlikely to have a deleterious effect on competition among wireless telecommunications services lead to the conclusion that the public's interest in PCS will be best served if LECs are allowed to be full and equal participants in this industry.

I examine the case for cellular operators participating in PCS as holders of licenses to PCS spectrum in their cellular service areas in Section V. As with LECs, there is a strong likelihood of significant economies of scope while the threat to competitive efficiency is minimal.

I consider various policy issues raised by spectrum auctions and lotteries in Section VI. Lotteries have certain advantages over auctions. Restrictions on post-award transfers, or rapid build-out requirements, would be detrimental to the efficient development of PCS.

I summarize my findings and my policy conclusions in Section VII.

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II. Small service areas will best serve the Commission's efficiency and competitiveness objectives.

The size of service areas to be licensed for PCS is one of the most important issues to be resolved in this rulemaking. As I show below, service area size has a direct bearing on the speed and efficiency with which the industry identifies services and technologies that satisfy marketplace needs. Service area size also affects the ability of the industry to arrive at a geographic and ownership configuration that allows it to provide its services efficiently.

The Commission specifically requested comments on the merits of the following options: (1) Rand McNally's Basic Trading Areas (BTAs); (2) LATA boundaries; (3) Rand McNally's Major Trading Areas (MTAs); and (4) nationwide licenses. The possibility of a mixed scheme, such as reserving a portion of PCS spectrum for MTA licenses and allocating the rest to BTA licenses, is also suggested. The MSAs and RSAs licensed for cellular service are another widely discussed option, which would produce smaller service areas than the above options.

The NPRM offers two reasons for preferring PCS service areas larger than those licensed for cellular telephone. One is that the combination of the lottery procedures employed and the number of licenses awarded in licensing cellular services was costly and an administrative burden to the

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Commission. The second, which is by far the most important, is the possibility that substantial transaction costs associated with reconfiguring the cellular industry after licenses were awarded could be avoided in PCS by licensing larger service areas. My analysis focuses on the economic efficiency implications—including effects on transaction costs—of alternative licensing schemes. The administrative costs associated with awarding PCS licenses will be incurred only once and are bound to be trivial in comparison to the potential ongoing costs of reduced economic efficiency should an inappropriate licensing policy make it more difficult for the market to facilitate carriers' and users' choices among alternative services and technologies or should it stand in the way of the development of efficient geographic and ownership structures for this new industry.

A. Perspectives on Transaction Costs

The transactions cost argument for larger service areas is based on one interpretation of recent trends in the cellular industry. As a consequence of the manner in which cellular wireline licenses were initially awarded and recent consolidation of ownership, regional clusters of service territories under common ownership are now a prominent structural feature in the cellular industry.[1] The Commission suggests that the transactions costs incurred in putting

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[1] Later in this section I present evidence showing that most cellular clusters are not of MTA or even BTA size.

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together regional clusters for cellular service might be avoided in PCS by licensing larger service areas.

Transaction costs are important and should be taken seriously, but they are just one of a number of factors that must be considered if licensing policy is to be used to promote economic efficiency in the provision of personal communication services. To a large extent, economic efficiency is a reflection of industry structure. In addition to a level of market concentration sufficiently low to encourage vigorous competition,[2] an efficient industry structure for PCS would have the following attributes: (1) the combination of services and technologies that maximizes benefits net of costs to PCS users; (2) ownership of the industry's assets residing in the hands of the firms that can operate them most effectively; and (3) a pattern of geographic concentration that makes it possible to take advantage of potential organizational and technical economies of scale. An industry that exhibits these structural features will provide greater economic benefits than one that does not. Of course, the speed and costs incurred in achieving an efficient industry structure are also important.

The transaction costs argument for larger service areas advanced in the NPRM focuses on the achievement of the third attribute of an efficient industry structure to the exclusion

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[2] This question is addressed with respect to PCS in Sections IV and V of this paper.

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of the first two. In the analysis presented below I show that small service areas have clear advantages for promoting the achievement of the first two attributes. In addition, a careful examination of both evidence and theoretical considerations suggests that the balance of advantages probably lies with small service areas for the achievement of the third attribute of an efficient industry as well.

B. Facilitating the Evolution of PCS Services and Technologies

PCS policies must address the needs of an industry that has yet to define its services and develop its technologies. Today PCS represents the potential for a yet to be determined family of wireless, portable services with widely varying levels of functionality. In the long run, the market will determine the collection of service offerings and delivery technologies that will constitute PCS. By contrast, the first cellular licenses that were awarded in 1982 were for the provision of a tightly prescribed set of services based on a technology that had been developed over a decade earlier in AT&T's Bell Labs and set forth in rules adopted by the FCC.[3] Competitive forces operate very differently in a market where the selection of services and delivery technologies is still up for grabs than in a market where these issues are already resolved. Therefore, it is

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[3] Rohlfs, J., Jackson, C., and Kelley, T., "Estimate of the Loss to the United States Caused by the FCC's Delay in Licensing Cellular Telecommunications," National Economic Research Associates, November 8, 1991.

important that PCS licensing policy be developed with the
need of a new industry to explore the potentials of embryonic
technologies and services in mind. To set the stage for the
policy recommendations that follow, I will first briefly
discuss the evolutionary dynamics of new industries.

1. The Economics of Industry Evolution

Theory. David Teece,[4] borrowing heavily from earlier
work by Abernathy and Utterback,[5] has provided a useful
conceptual framework for describing the developmental phases
many industries pass through as they progress from their
early, uncertain beginnings to a more stable, "mature" phase.
During the earliest phases of an industry's development,
which Teece calls the preparadigmatic stage, "[c]ompetition
among firms manifests itself in competition amongst designs
[paradigms], which are markedly different from each other."[6]
Eventually, after a period of trial and error, the market
settles on one or a few dominant designs that experience has
shown to do a better job of meeting user needs.

Once the identity of the dominant design (or designs)
becomes apparent, the industry enters its paradigmatic stage,
where price competition is more important and winners and
losers are selected on the basis of their ability to supply

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[4] Teece, D., "Profiting from Technological Innovation: Implications
for Integration, Collaboration, Licensing and Public Policy," *Research
Policy*, 15 (1986), 285-305.
[5] Abernathy, W. J. and Utterback, J.M., "Patterns of Industrial
Innovation," *Technology Review*, 80 (1978), 40-47.
[6] Teece, op. cit., p. 288.

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products and services incorporating the dominant design reliably and at low cost. Innovation may continue during the paradigmatic stage, but it is likely to be reflected in incremental improvements in products and production processes based on the dominant design, rather than new product innovations that depart radically from accepted standards. The early phases of the paradigmatic stage may be characterized by a "shakeout" period during which less efficient firms exit the industry with their assets often being absorbed by the surviving firms as the industry consolidates. The winners of the efficiency-based competition during the paradigmatic stage will be the major players in the mature industry.

<u>Example of Personal Computers</u>. The history of the personal computer industry illustrates these stages in the evolution of a high tech industry.[7] The first commercial personal computer was MITS' Altair, first marketed as a kit in *Popular Electronics* in early 1975. By the end of 1977 over fifty firms were competing in this industry. Most of these computer ventures failed quickly.

Apple entered the PC industry in 1976 with the Apple I, which sold about 200 units, mostly in the San Francisco Bay

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[7] For the most part, this brief review of the history of the personal computer industry draws on the following sources: Freiberger, P. and Swain, M., *Fire in the Valley*, Osborne/McGraw-Hill, Berkeley, 1984; Chposky, J. and Leonsis, T., *Blue Magic: The People, Power, and Politics Behind the IBM Personal Computer*, Facts on File Publications, New York, 1988; and Forester, T., *High-Tech Society*, MIT Press, Cambridge, 1987.

Area. The Apple II, which soon became the industry leader, was introduced in April 1977. By the end of 1981, Apple was fighting with Tandy for the lead in personal computer sales. Other prominent PC brands at this time were Osborne, Atari, Commodore, Hewlett-Packard, Radio Shack, Texas Instruments, Xerox, Zenith, and IBM (a new entrant). About 150 smaller companies made up the rest of the industry. The six short years since the introduction of the Altair had seen the entry of hundreds of different brands of personal computers embodying a wide variety of technologies, features, and approaches to the market.

The introduction in 1981 of IBM's 16 bit personal computer with the MS-DOS operating system marked the beginning of the end of the preparadigmatic stage of the PC industry. MS-DOS soon became the industry standard, with IBM the clear leader in sales.[8] In October 1983 *Business Week*[9] proclaimed IBM the winner of the PC wars.

Competition during the paradigmatic stage of the PC industry has turned on the ability to efficiently manufacture and market machines based on the MS-DOS standard. IBM dominated sales of MS-DOS PCs early on with its market share

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[8] Apple was the lone, significant holdout maintaining a proprietary operating system, first with the Apple II, followed by the Macintosh line of PCs. As it lost market share to makers of PC clones in the late 1980's, IBM responded by introducing a new operating system, OS/2. While OS/2 has enjoyed modest success, it has done little to end the dominance of MS-DOS machines.

[9] "Personal Computers: And the Winner is IBM," *Business Week*, October 3, 1983, 76-79, 83, 84, 90, 96.

rising to over 50 percent by 1985,[10] but eventually saw the bulk of industry sales captured by manufacturers of "clones," offering reliable MS-DOS machines at substantially lower prices and who even began to advance the capabilities of PCs based on this standard at a faster rate than IBM. Major clone makers such as Compaq and Dell and dozens of smaller brands now account for the bulk of MS-DOS machines.

Implications. From the vantage point of a mature industry, it is tempting to view the often considerable investments in approaches that failed to make the final cut as wasted and unnecessary. But this would be incorrect. When it is not known which approaches are superior in advance, the market process proceeds on the basis of trial and error. The costs of failed experiments represent an unavoidable part of the price that has to be paid to identify those approaches that best meet the needs of the marketplace. This is the only way to find out what works and what doesn't. Furthermore, innovations introduced with failed products often reappear as features of later successes.[11]

In the long run an industry is likely to do a better job of meeting its customers' needs if it is able to choose among a large number of alternative technologies, features,

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[10] "Small Business Bolsters PC Sales," *MINI-MICRO SYSTEMS*, June 1986, 85, 86, 91, 93.
[11] For example, the first computer to combine the CPU and monitor to form a single unit was a failure that bankrupted IMSAI, the company that introduced it. But this combination was a feature of a number of subsequent PCs that were commercial successes, including the first models of the highly successful Macintosh computer.

marketing approaches and providers early in its
preparadigmatic stage. Artificially limiting the rate at
which entrepreneurs can introduce competing visions of the
appropriate approach to the market at this stage threatens
economic efficiency in two ways. One is that slowing the
speed at which the market can screen alternatives increases
the likelihood that it will settle on a dominant approach
before it has examined superior options further down in the
queue.

For PCS, as with most communication industries, we can
anticipate that an approach will be more valuable to each of
its users the more widely it is used. This occurs because,
among other reasons, the value of being able to use a
technology to communicate with other users of the technology
grows as their numbers increase,[12] and because the prices of
products and services based on a new technology typically
fall significantly as the number of users increases. This
means that an approach that attracts a substantial group of
users early in the preparadigmatic stage may have an

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[12] For example, Paul David argues that the standard arrangement of keys
on keyboards for typewriters, workstations, and personal computers was
developed in an era when mechanical typewriters made it desirable to
slow the pace at which typists struck the keys. In the current era of
electronic keyboards, other arrangements of the keyboard would make
typing more efficient, enough so to more than compensate for the
opportunity cost of the time required to retrain typists to work with
alternative key layouts; but manufacturers of redesigned keyboards have
not been able to find significant markets for their innovations because
all typists are trained for the QWERTY key layout. At the same time,
individual typists see no profit in developing proficiency with other
keyboards when there are so few of these keyboards to work with. David,
P., "Understanding the Economics of QWERTY: The Necessity of History,"
in W. Parker, ed., *Economic History and the Modern Economist*, Cambridge:
Basil Blackwell, 1986.

insurmountable advantage over superior approaches brought to market at a later date.[13] Therefore, it is vital that there be a lot of experimentation as the industry is getting under way. If the market selects the best of a bad lot available early on, it may not be possible to introduce superior approaches later on. Slowing the pace at which the market can evaluate a wide range of options increases the likelihood that a suboptimal alternative will be chosen.

Second, even if the selection of suboptimal approaches was not a serious concern, there would still remain the potentially large opportunity cost of delaying the widespread implementation of the best approaches because the market's selection process was prolonged.[14] A simple example illustrates this point. Suppose we want to pick the best of ten candidate approaches and prior knowledge gives us no hint as to which is best. We could proceed by experimenting with each of them one at a time. If each experiment takes one period to complete and the best approach is obvious once its experiment has been run, then we would normally expect about

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[13] For a particularly lucid statement of this point, see David, P., "Some New Standards for the Economics of Standardization in the Information Age," in P. Dasgupta and P. Stoneman, eds., *Economic Policy and Technological Performance*, Hew York: Cambridge University Press, 1987. See also S. Besen and G. Saloner, "The Economics of Telecommunications Standards," in R. Crandall and K. Flamm eds., *Changing the Rules: Technological Change, International Competition, and Regulation in Communications*, Washington, D.C.: Brookings Institution, 1989, for an analysis of standard setting and standards coordination in telecommunication industries.
[14] In fact, even if the superior approaches were among the first tested, the market might be slow to adopt them because their superiority could not be established until a large number of options had been screened.

five periods to elapse before the best approach is revealed. More realistically, we would probably have to use ten periods to examine all of the approaches to determine on the basis of comparison which is best. (The opportunity cost of waiting through this type of process is one of the reasons the market may settle on an inferior approach before all options have been considered.) Alternatively, we might allow experiments with all of the approaches to proceed simultaneously during the first period. Comparing the results of these experiments would allow us to implement the best approach universally by the second period.

2. Applying Economic Theory to PCS: Small service areas will facilitate the development of PCS during its preparadigmatic stage

PCS Market Experiments. PCS clearly is at the very beginning of its preparadigmatic stage. To date there has been limited exploration of PCS technologies through the 150 plus experimental licenses granted by the FCC. Published reports and trade discussions of the range of PCS services that might be provided and the alternative technologies for delivering them show that the market will have a wealth of options to sort through once the spectrum required to offer these services is made available. But true preparadigmatic market testing of alternative approaches to PCS awaits the Commission's action in this rulemaking.